Reflectivity Measurements

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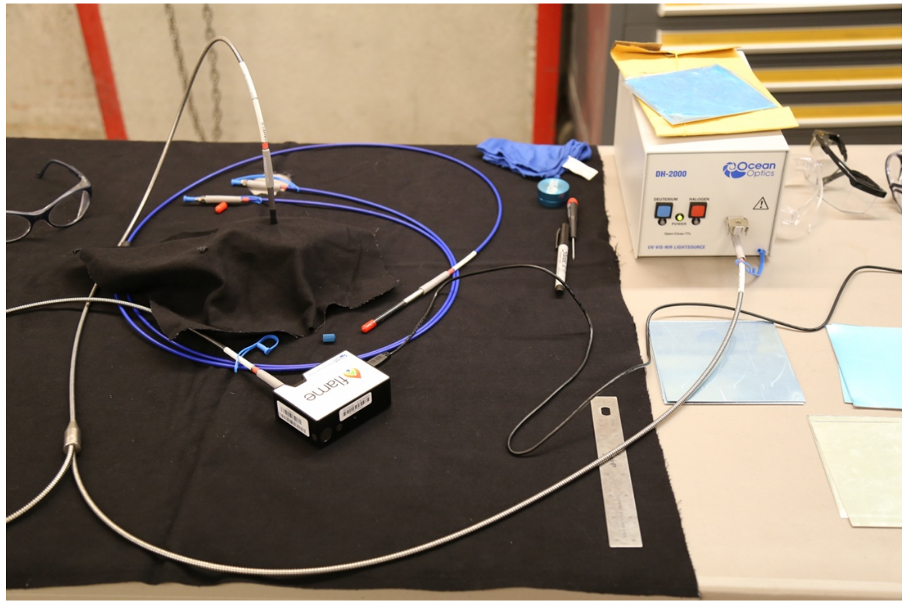
April 30, 2016

Reflectivity Measurements

Outline

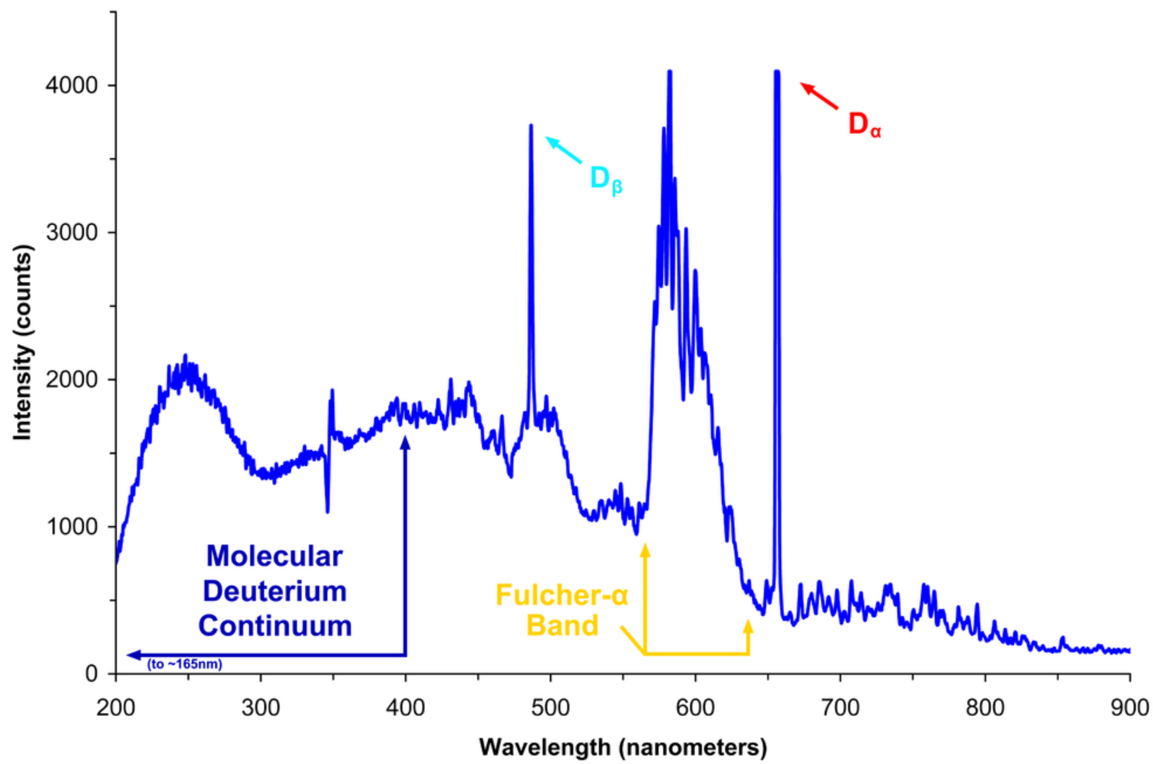
- Apparatus
- Calibration
- Recent measurements
- Irradiation Study
- Summary and Plans

Reflectivity Measurement Apparatus



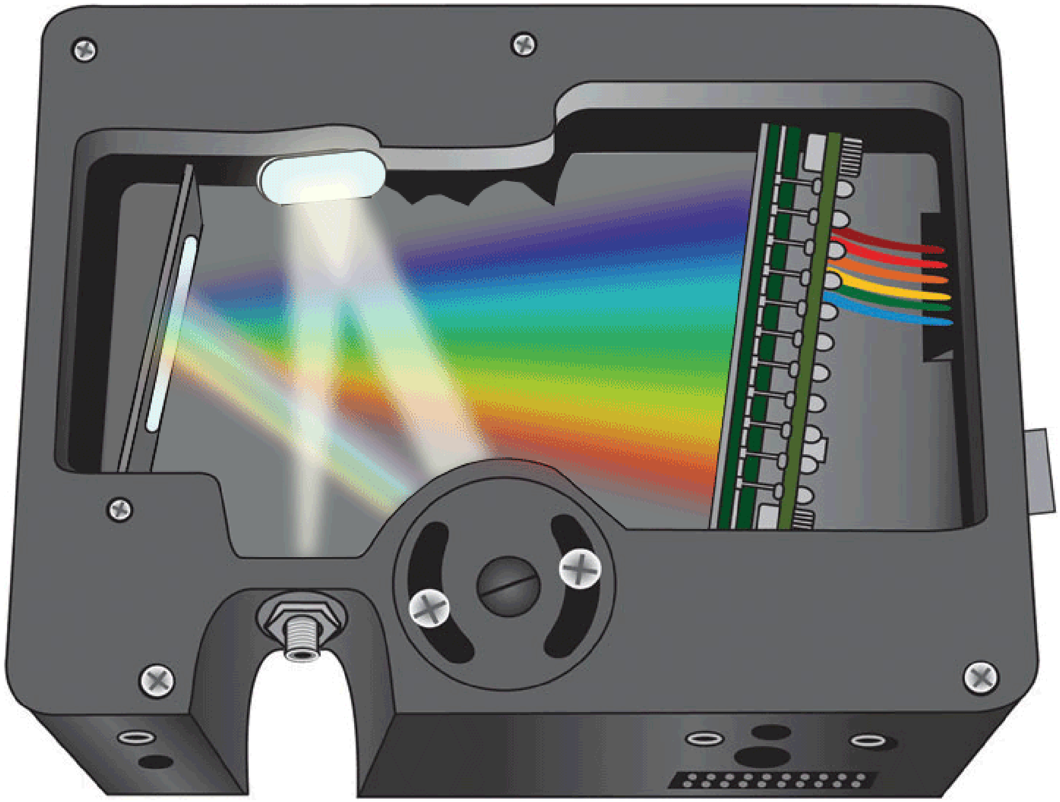
- Light source: Ocean Optics DH2000: 200-800nm, 25W Deuterium bulb
- Spectrometer: Ocean Optics USB Flame, enhanced sensitivity, UV-VIS grating/config. Probes: QR400-7-SR and R400-7-SR
- NIST specular calibration standard with traceable data
- Custom measurement stand

Deuterium Lamp Spectrum (from wikipedia)



- Hydrogen Balmer lines at 486 nm and 656 nm
- Continuum emission in the 160 - 400 nm range
- Fulcher band (ro-vibrational) emission around 560 - 640 nm
- Note decrease for $\lambda <\sim 250$ nm due to spect. efficiency loss

USB Spectrometer: FLAME-S-UV-VIS-ES

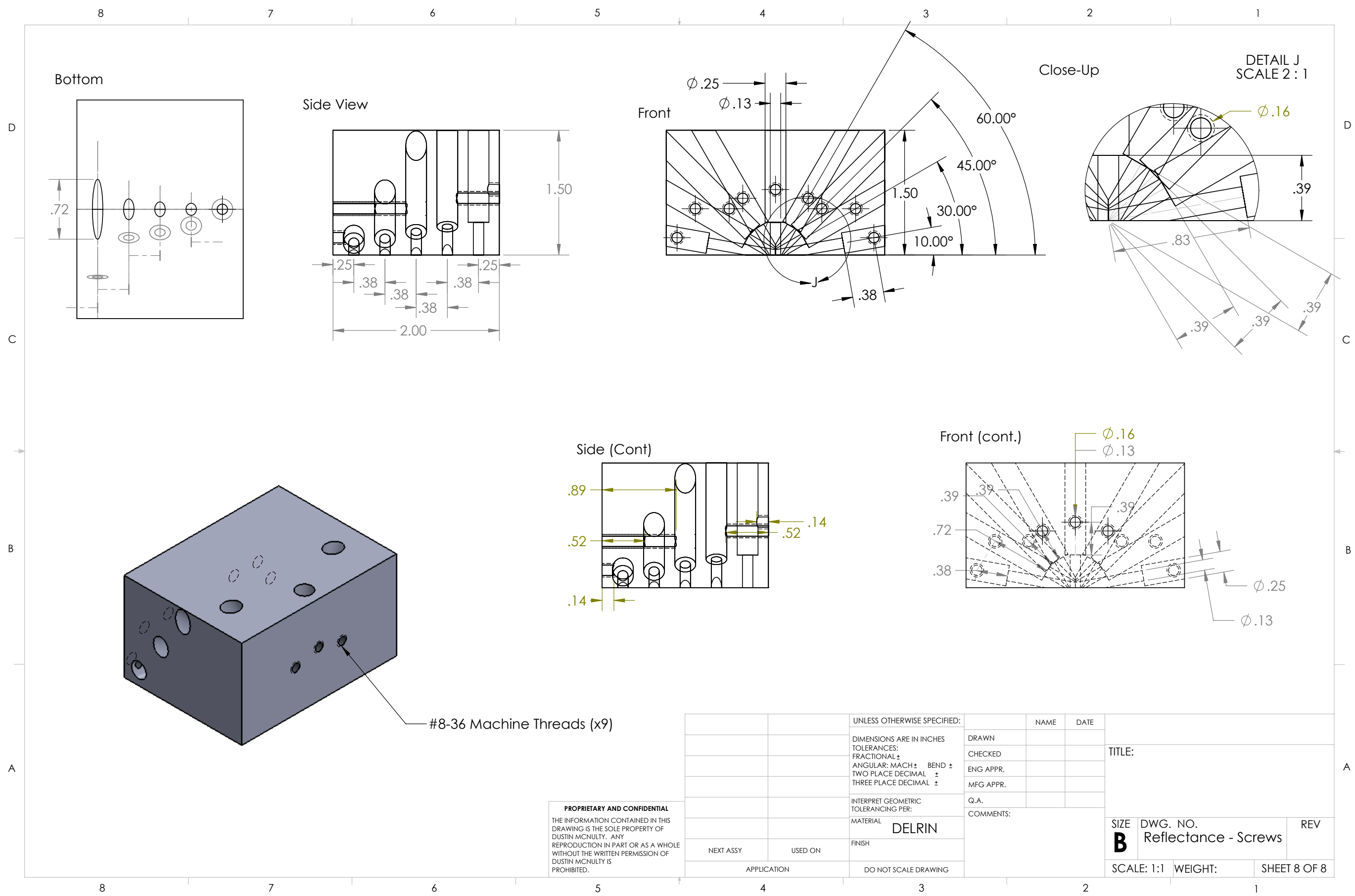


- Interchangeable slit entrance depending on application
- Collimating mirror to grating (setup for UV-VIS)
- Focusing mirror to 2048 channel CCD with collector lens (ES)

Specular Reflection Calibration Standard STAN-SSH-NIST

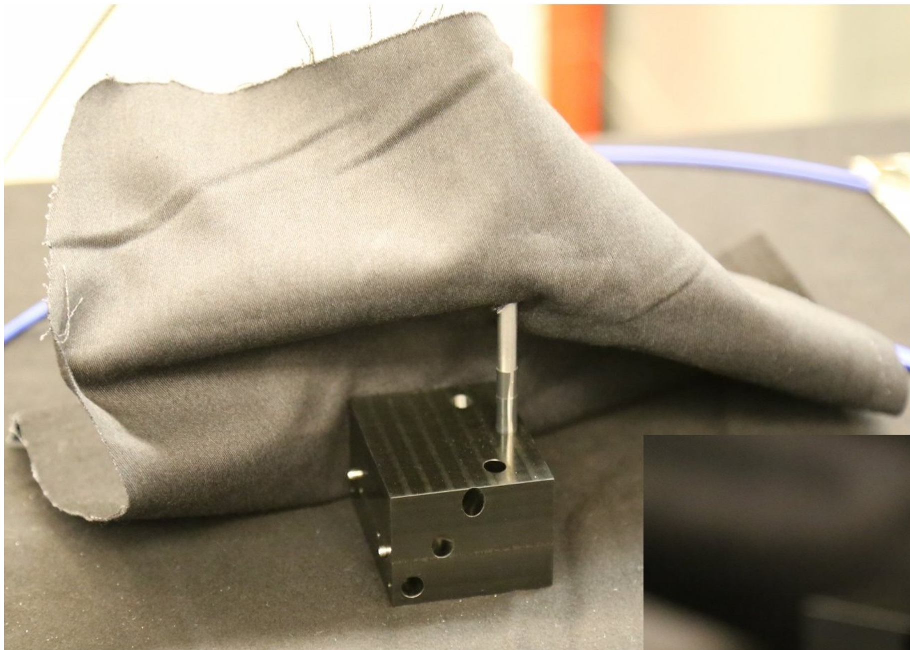
- Aluminum mirror on fused silica substrate
- $\sim 87\% - 93\%$ reflectivity (250 - 1000 nm)
- NIST calibration data included (250 - 2500 nm)

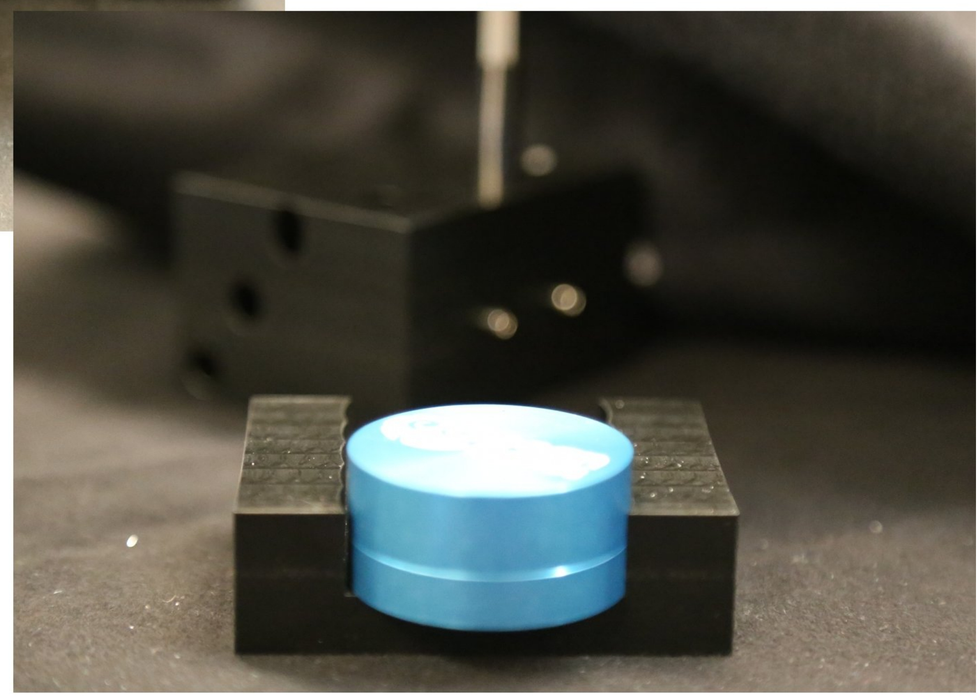
Measurement Stand



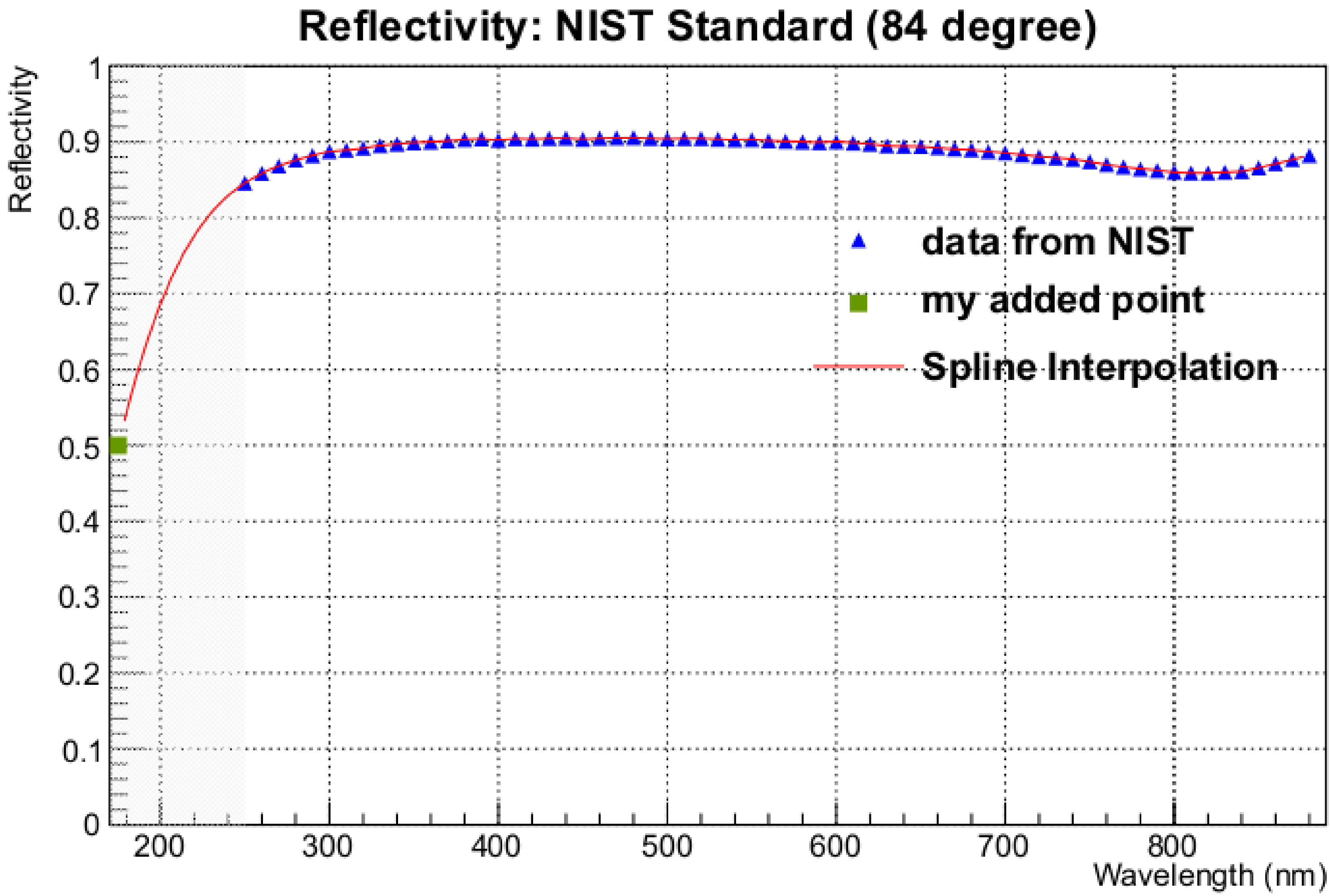
- Machined from black Delrin; designed for 90, 60, 45, 30, 10* deg
- Using 400μm fiber optic, angle uncertainty is $\pm 1.2^{o}$

Measurement Stand

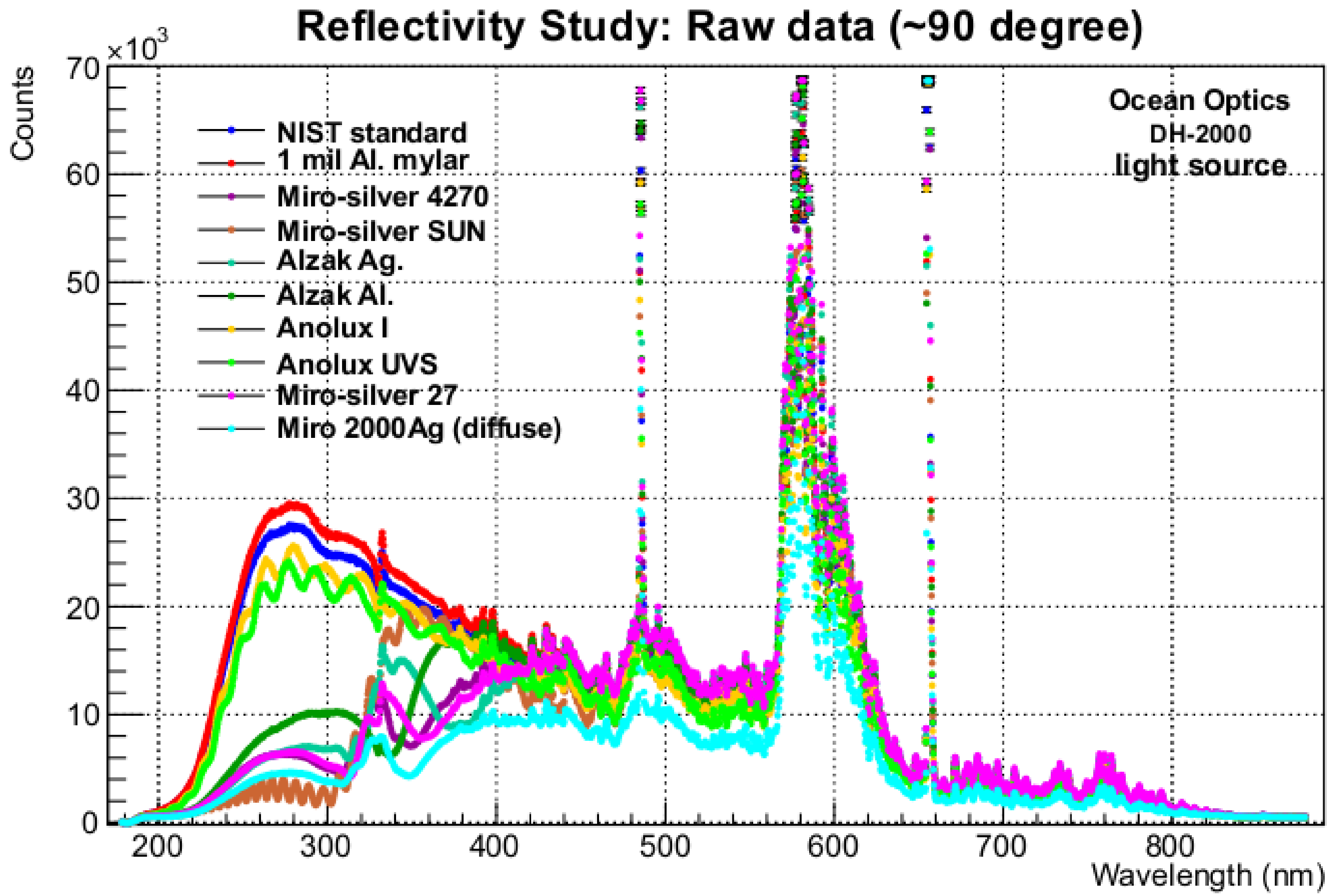




Calibration Data



Recent Measurements



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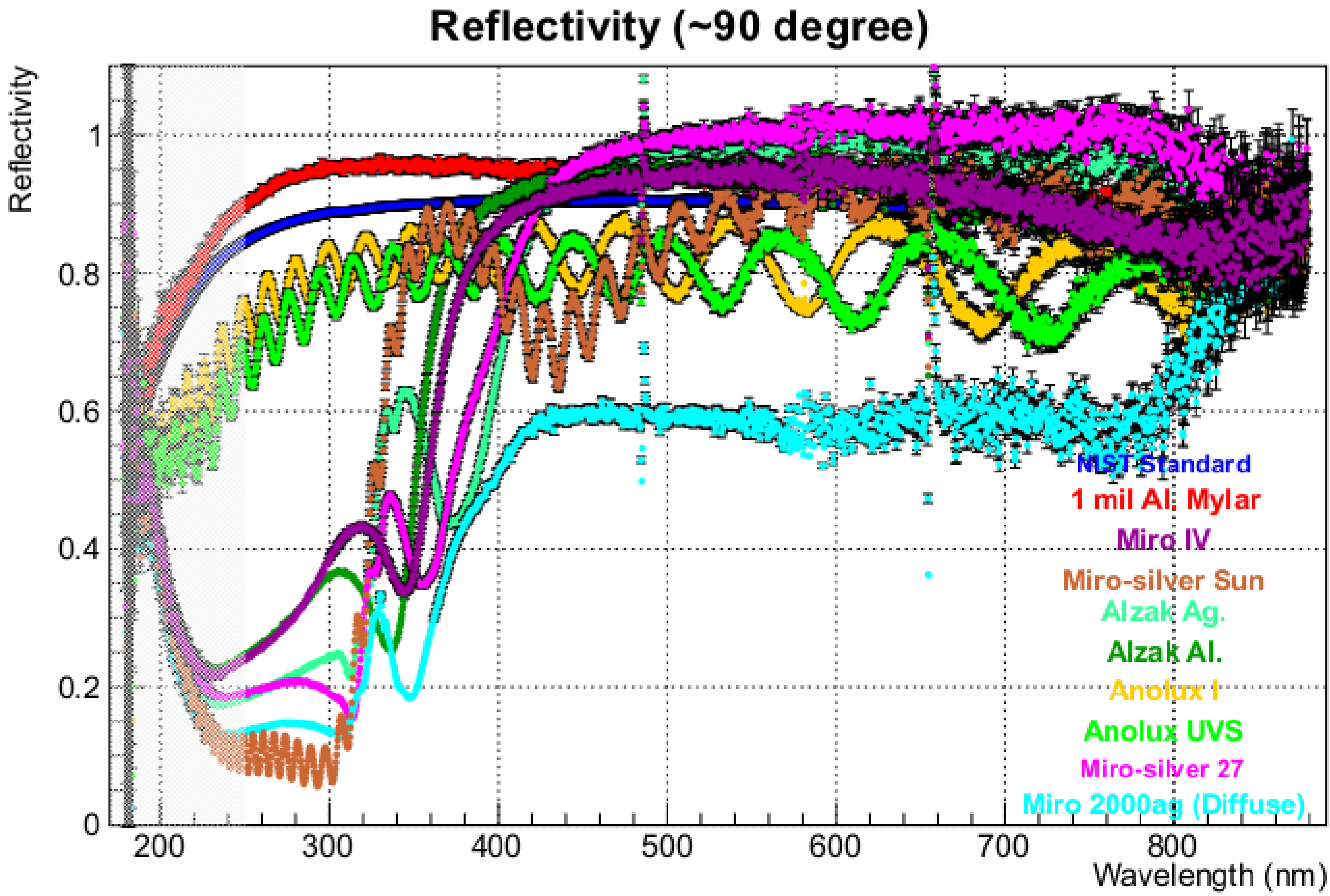
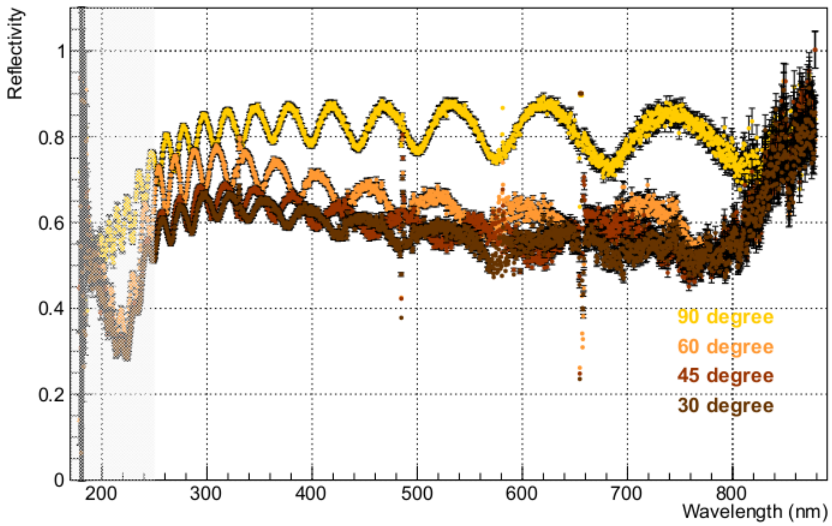
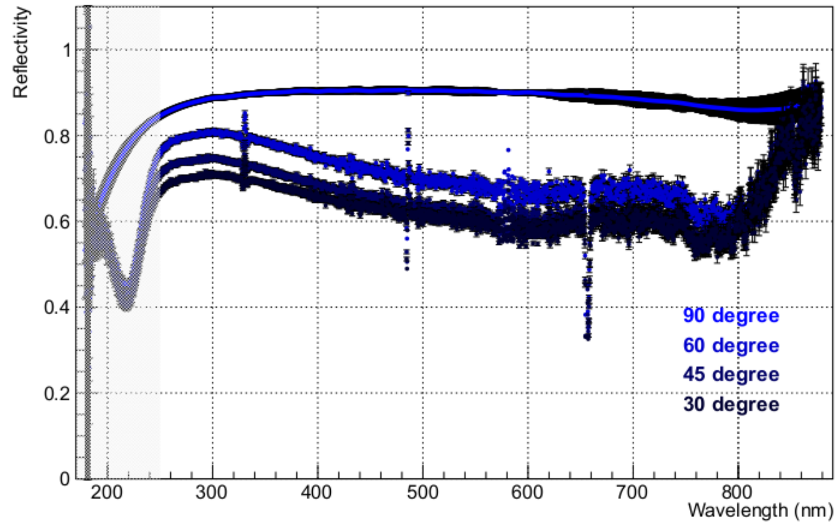


Recent Measurements

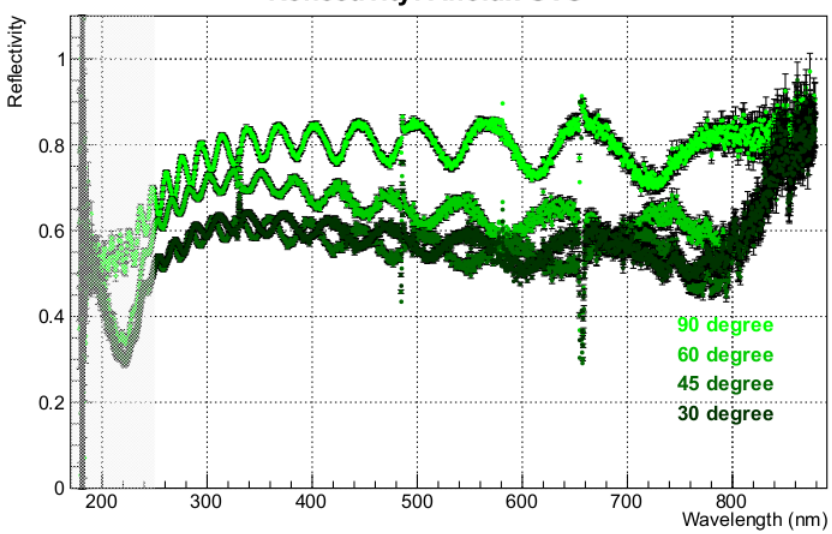
Reflectivity (Anolux I)



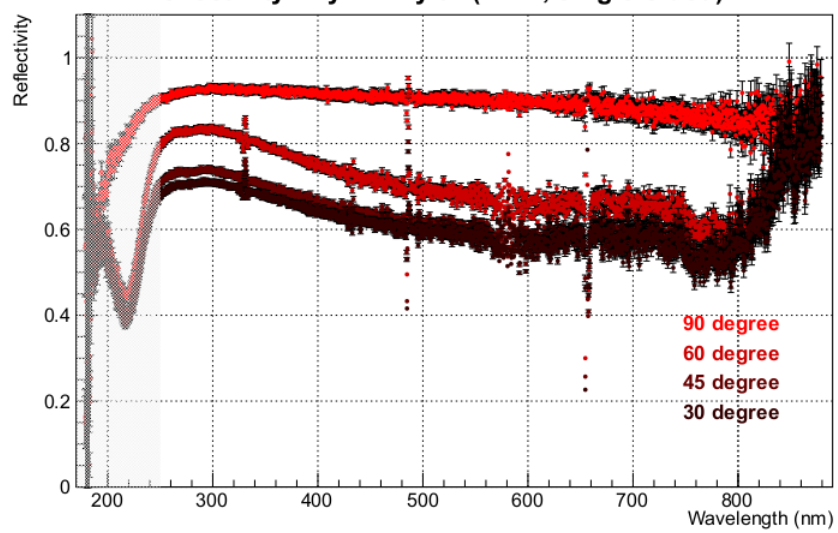
Reflectivity: Nist Standard



Reflectivity: Anolux UVS

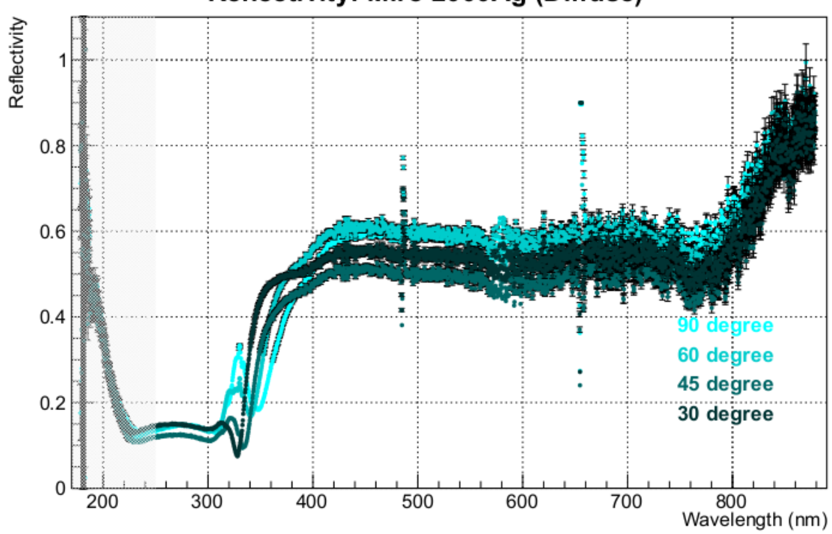


Reflectivity: my Al. mylar (1 mil, single-sided)

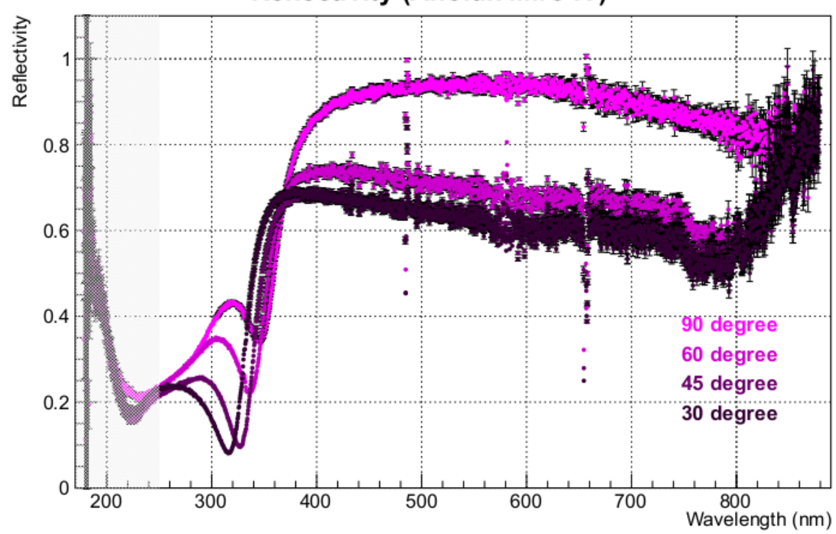


Recent Measurements

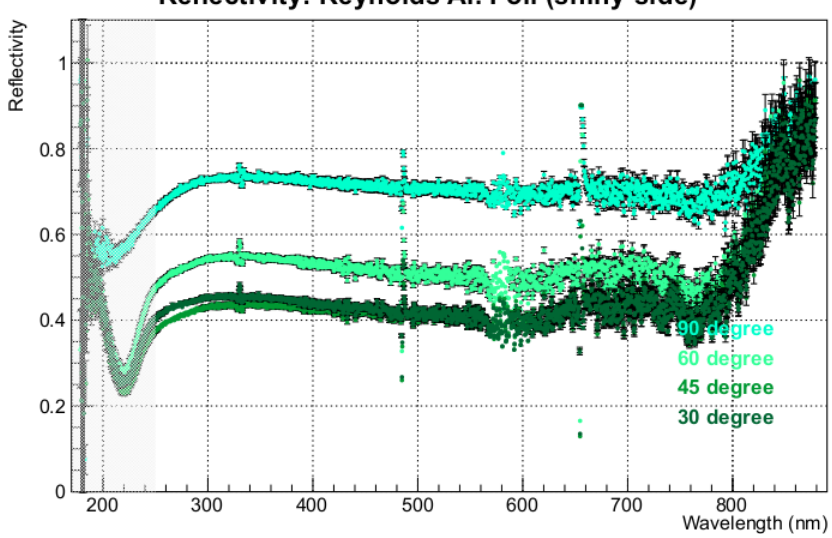
Reflectivity: Miro 2000Ag (Diffuse)



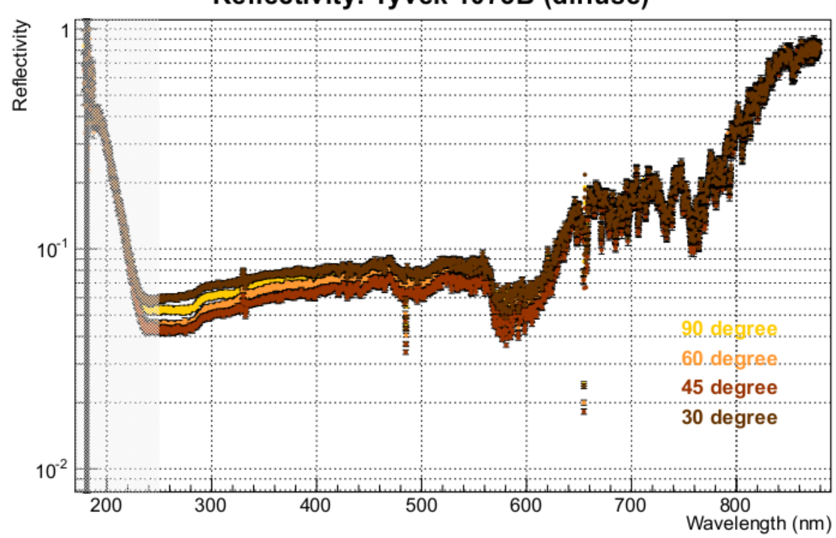
Reflectivity (Anolux Miro IV)



Reflectivity: Reynolds Al. Foil (shiny-side)



Reflectivity: Tyvek 1073B (diffuse)



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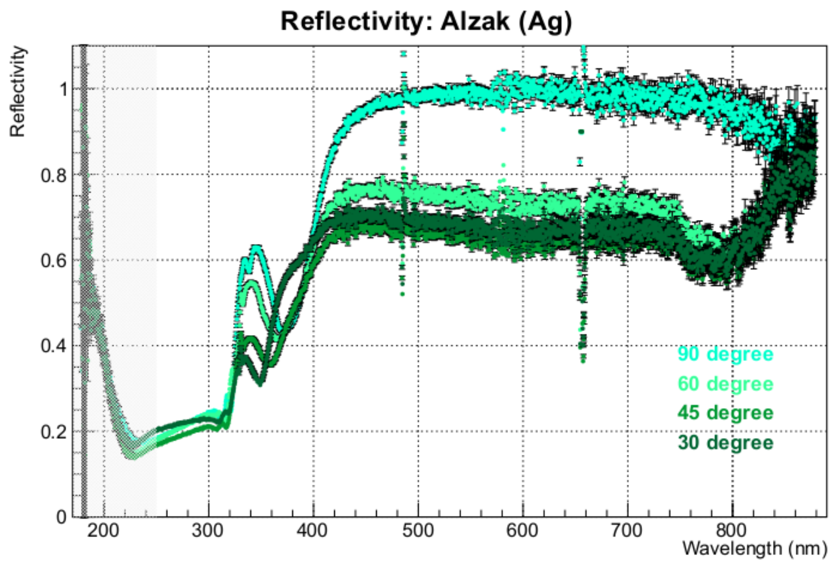
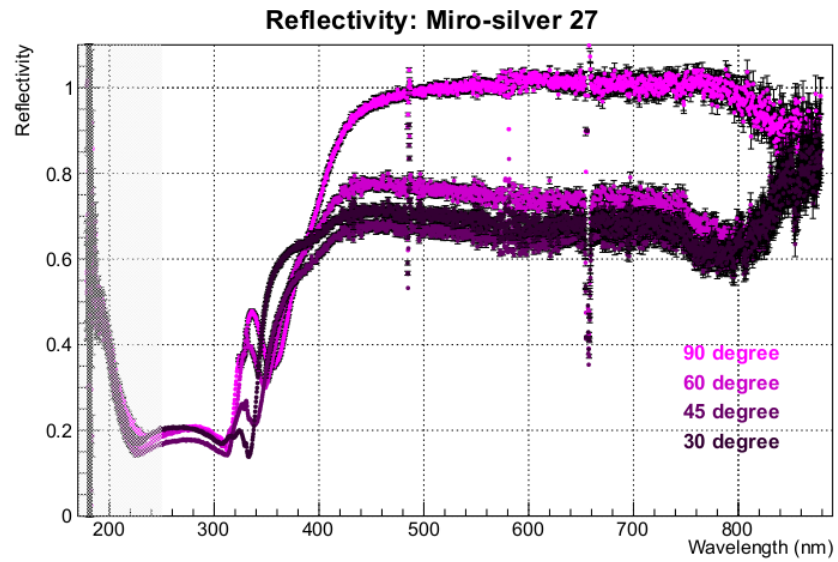
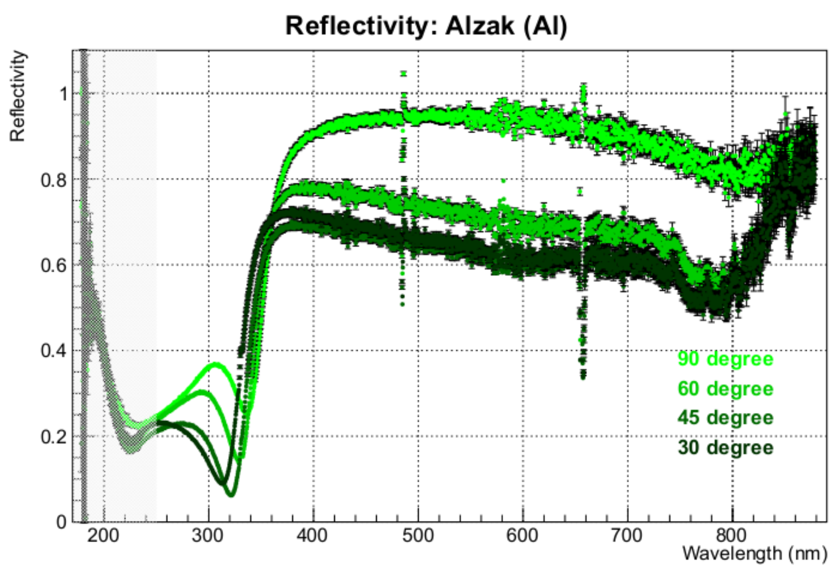
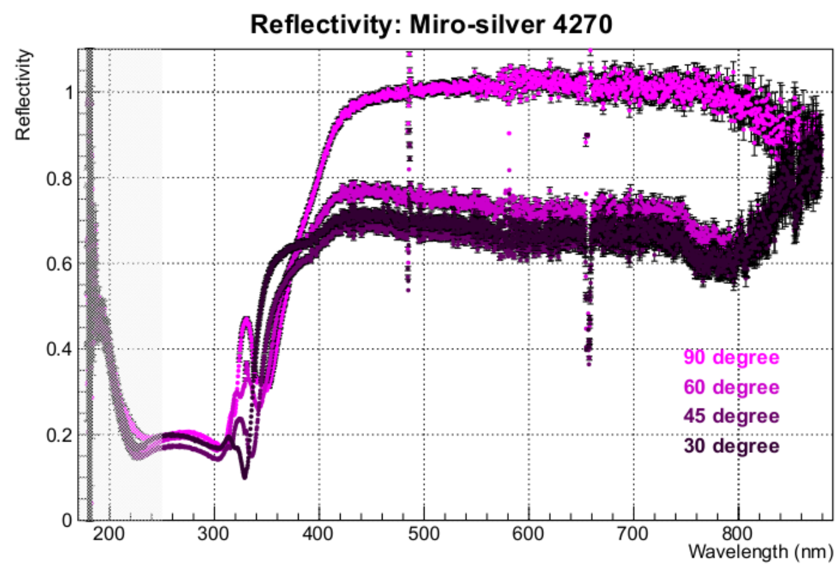








Lightguide Irradiation Study at IAC

25 MeV LINAC (Main Hall and Airport)

RF Frequency: 2856 MHz (S-Band)

Energy Range: ~4~25 MeV (current varies)

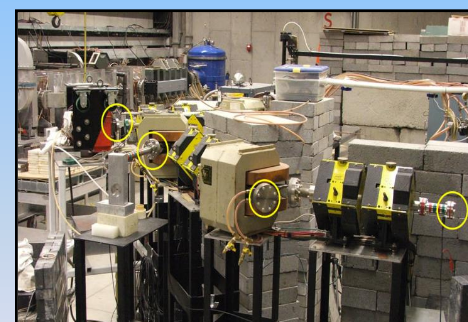
Pulse Width: ~50ns to 4 micro seconds

Repetition Rate: single pulse to 360 Hz

Ports: 0 degree, 45 degree and 90 degree (Beam energy resolution ~ 1+/- 15%)

25B Energy vs Current

Energy (MeV)	0 port (mA)	45 port (mA)	90 port (mA)
23	55	55 @ 3.8uS	46 @ 3.6 uS
20	100	70 @ 4 uS	65 @ 4 uS
16	100	48 @ 3.6 uS	48 @ 3.6 uS
13	80	30 @ 3.3 uS	15 @ 3.3uS
10	60	18 @ 3 uS	7.5 @ 3 uS
9	110	30 @ 4uS	15 @ 4 uS
6	100	60 @ 4 uS	60 @ 4 uS
4	50	20 @ 4 uS	20 @ 4 uS

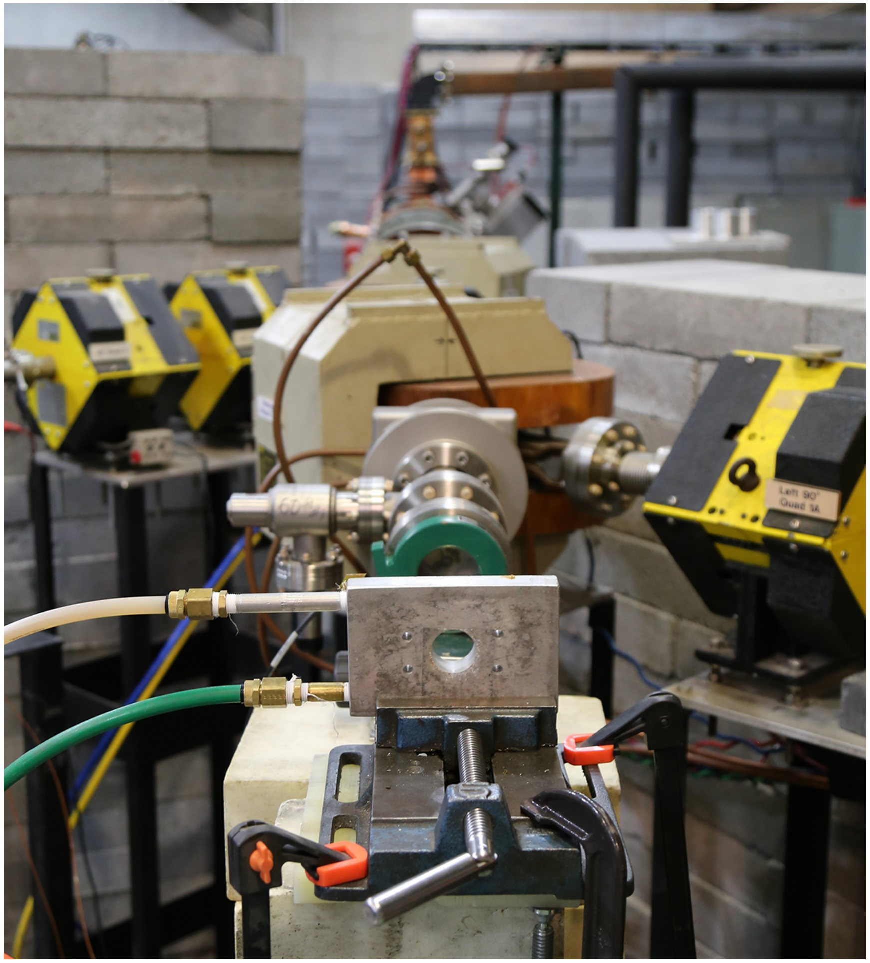


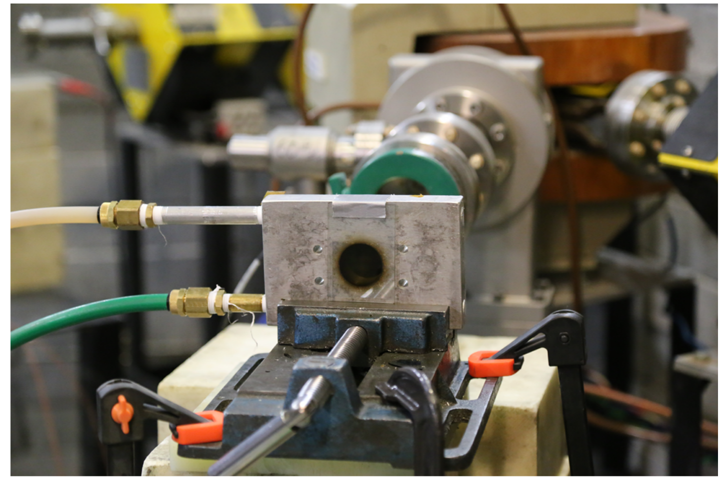
ISU

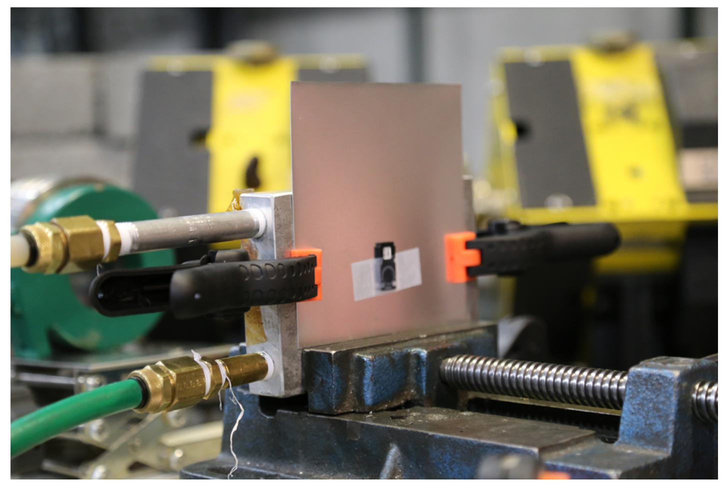
Idaho Accelerator Center

- Operated at 8 MeV, 65 - 110mA I_{pk}, 4μs pulse width at 250 Hz

Irradiation Study: Beamline Setup

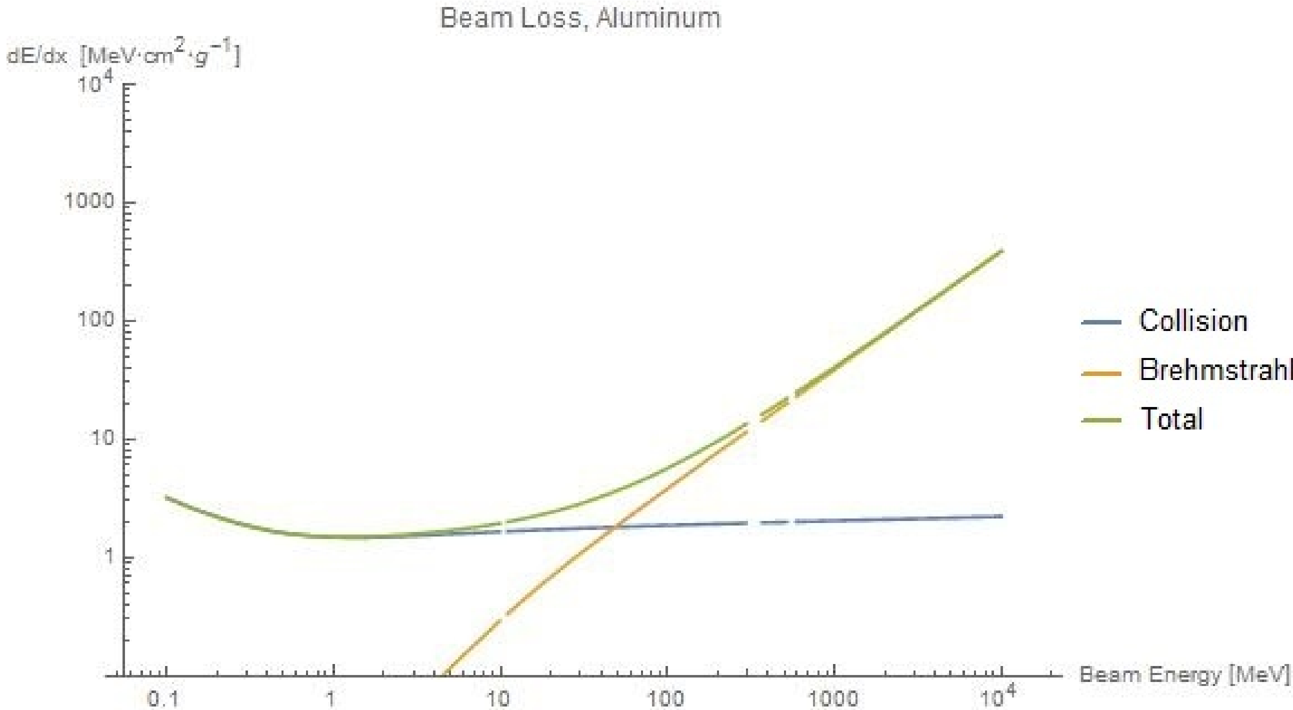






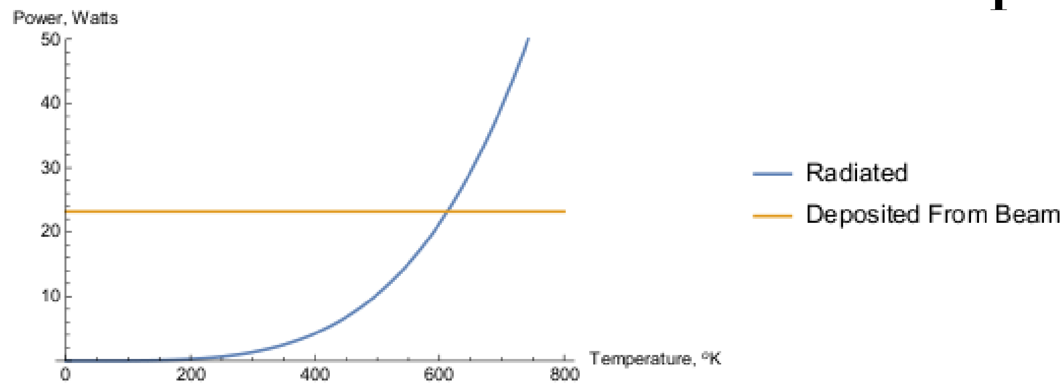
- Water-cooled (15 °C) aluminum brick with 1.5 cm radius hole
- Incident beam power up to 880 W for 8 MeV

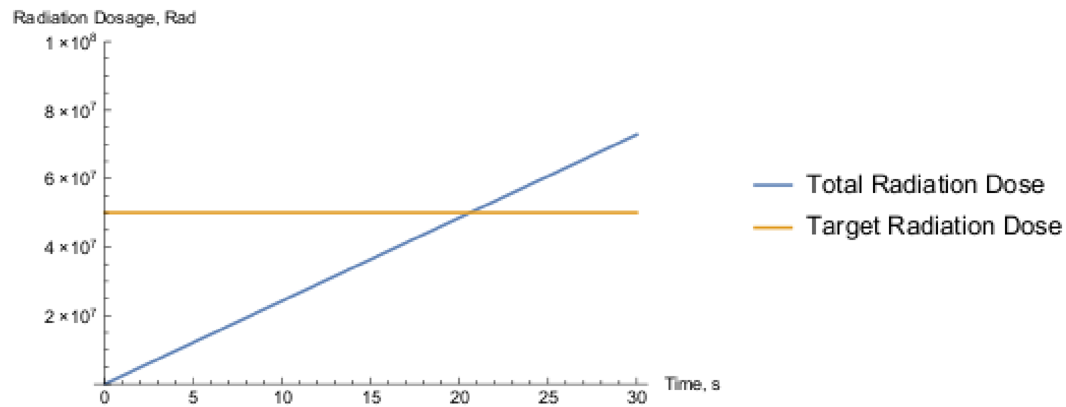
Calculations: dE/dx for Aluminum



- Collisional losses for 8 MeV e^-: 11.9 MeV/cm; neglect Brems
- $\langle$energy loss$\rangle \sim 0.59$ MeV for 0.05 cm thick aluminum
- Initial beam: (8MeV)(65mA)(4μs)(150Hz) = 310 W incident
- $\sim 1.6\times10^{12}$ e^-/pulse. Deposited power: $\sim$22 W

Calculations: Thermal and dose exposure



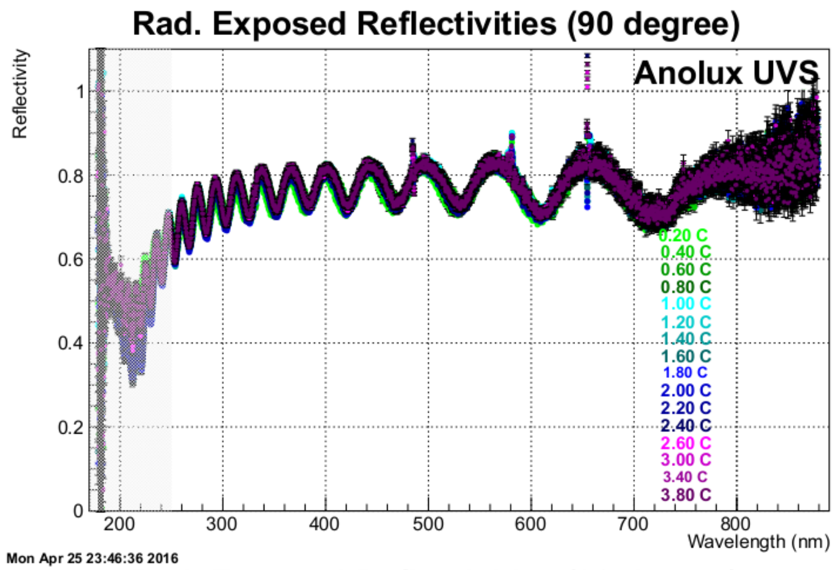


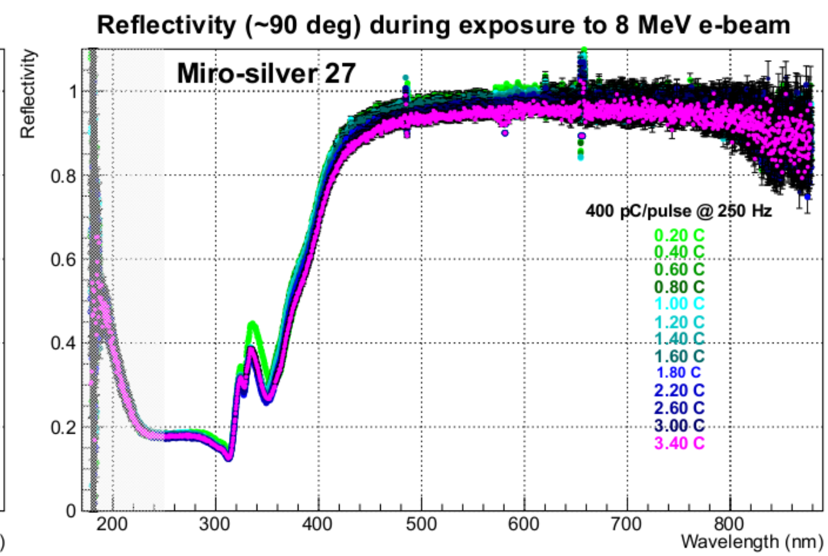
- For 22 W deposited beam power, samples will not melt even if only assume radiative cooling ($T_{\mathrm{melt}} = 933$ K)
- Dose rate = 22 W/exposed mass = 23 kGy/s or 2.3 Mrad/s; achieve 50 Mrad exposure in 20 s; measured 1.3 Mrad/s

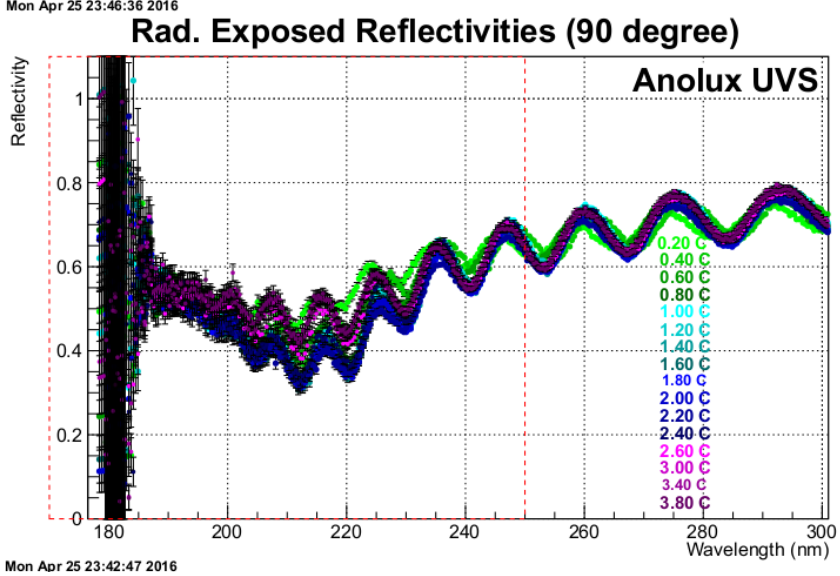
Irradiated several lightguide material samples over a 3 day period from Mar 22 - 24, 2016:

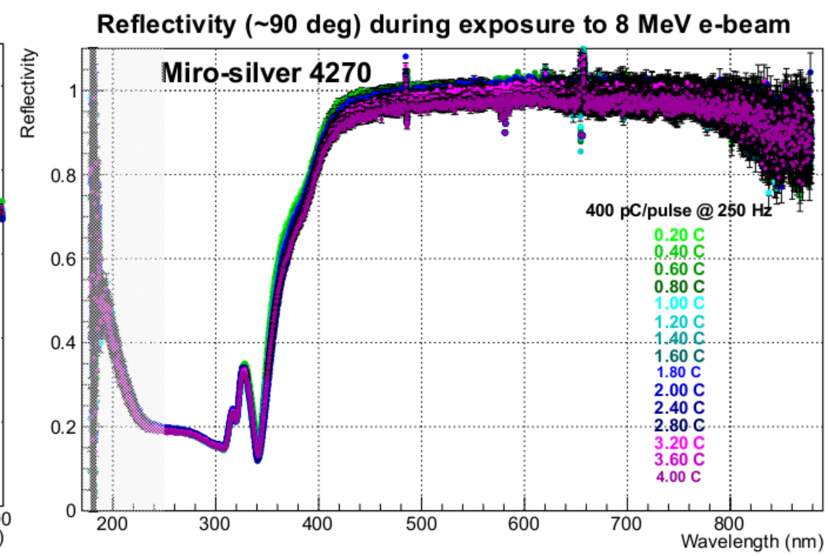
- Miro-silver 4270
- Anolux UVS
- Miro 2000Ag (diffuse)
- Miro-silver 27 (from Michael)
- Alzak-Al and Alzak-Ag (from KK)
- 1 mil, single-sided aluminized mylar (from Bogdan W.)

Reflectivity's following dose exposures

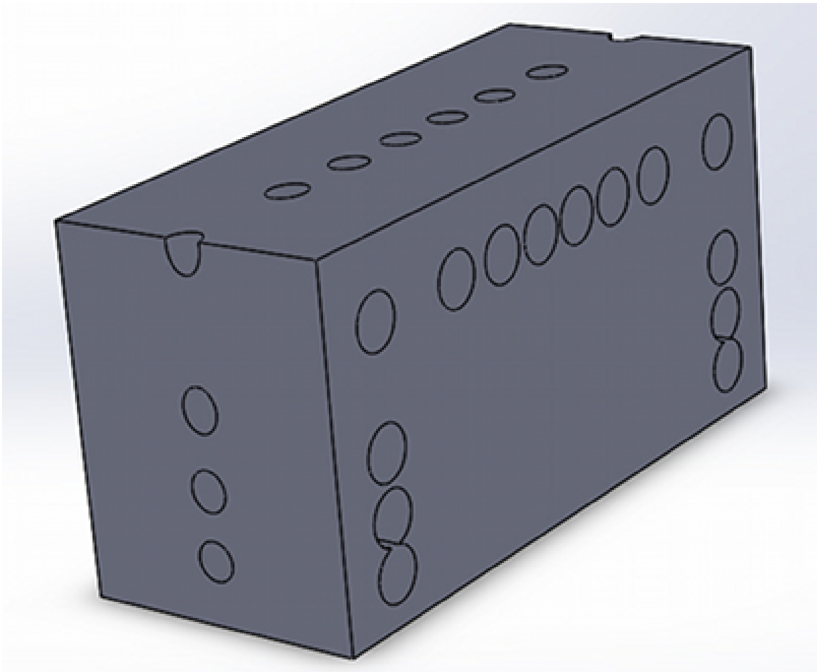


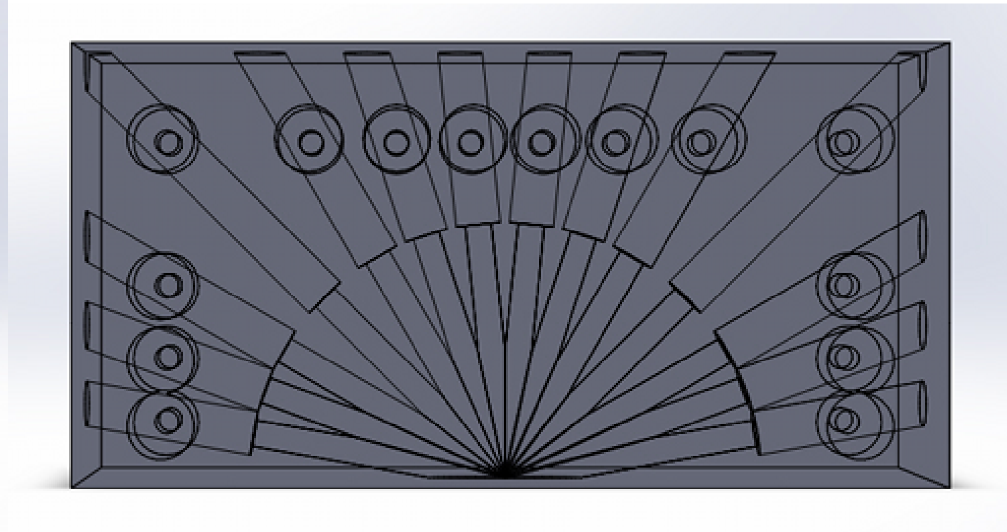






New reflectance measurement stand design





- Will measure 10, 20, 30, 45, 60 , 72, and 84 degree reflectivity's
- New design can make all measurements at same location on mirror (and in same plane) – reduce systematics
- Angle uncertainty is $\pm 0.30^{\circ}$

Summary and Future Plans

- Materials with silver are poor UV reflectors
- Materials with silver more sensitive to radiation although all reflectors tested seem robust (even the 1 mil al. mylar)
- New reflectance stand design. Will calibrate down to 10°
- Will build new stand this summer and repeat tests
- Can also repeat LG irradiation study (if needed); since dose exposure was uncertain
- Planning to design transmission measurement stand for quartz irradiation study
- Could also do Photon Activation Analysis (PAA) on materials to determine elemental/isotopic content; using 20 MeV electrons/photons

Tried to measure temp. with thermal imager